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(54) **Method of controlling transmission on a same radio channel of variable-rate information streams in radio communication systems, and radio communication system using this method**

Steuerungsverfahren für die Übertragung von Datenströmen mit veränderlicher Rate auf einem gleichen Funkkanal in Funkkommunikationsanordnungen, und Funkkommunikationsanordnung, die dieses Verfahren verwendet

Méthode de gestion de la transmission sur un même canal radio de flux d'informations de débits variables dans des systèmes de radio communication, et système de radio communication utilisant cette méthode

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(56) References cited:
EP-A- 0 212 667 EP-A- 0 241 229
EP-A- 0 399 611 EP-A- 0 472 511
EP-A- 0 493 287 EP-A- 0 538 546
WO-A-90/08436 US-A- 4 813 040
US-A- 4 888 770

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Description

[0001] The present invention relates to radio communication systems and more particularly it concerns a method of controlling transmission on the same channel of variable-rate information streams in these systems, and a system using this method.

[0002] Preferably, but not exclusively, the communication system is a mobile communication system, and the information streams are represented by coded speech signals and control signals of a speech communication on the user channel of such a system.

[0003] In the framework of research concerning future developments of mobile communications, it is being attempted to define general characteristics of systems presenting a high flexibility, so as to allow the introduction of services which today are even completely unknown or cannot be foreseen.

[0004] One example is that known as the 'Universal Mobile Telecommunications System'.

[0005] A performance which is considered as suitable is that these systems should be able to process variable-rate information streams. In fact, considering the preferred application, the two information streams (speech and control signals, meaning by the latter term both the conventional telephone signalling and the other signals, e.g. measurement results, handover commands, etc., typical of a mobile communication system) are variable-rate streams. The variability of the speech stream is due to the nature of the speech itself, the characteristics of which change during time, to the existence of pauses during a conversation, to the characteristics of the speaker, etc.

[0006] Also control signals comprise information of different nature, some of which must be transmitted periodically (e.g. results of measurements) while others (e.g. handover commands) are to be transmitted whenever necessary. Moreover, redundancy to be introduced to protect information may vary for both streams depending on the conditions of the radio channel.

[0007] Keeping this into account, access techniques to radio channels have been examined which are well suited to variable information stream processing, specially techniques of the type known as Code Division Multiple Access (CDMA). When these techniques are used, system capacity is linked to the average interference generated by active users: therefore each reduction of data transmitted at a given moment allows increasing the overall number of users served, and vice-versa, a reduction of traffic allows satisfying the requests for greater resources by certain communications.

[0008] In the case of a speech communication between a mobile station and a base station, it is possible to multiplex the two information streams, after the respective channel coding, on the same radio channel, since this solution is doubtless more efficient than the allocation of a physical channel to each stream. Considering that for each physical channel a maximum transmission rate is foreseen, which can vary depending on the system conditions, the problem arises of sharing conveniently the available bits between the two streams.

[0009] A spread spectrum communication system is already known, where two information streams at variable rates originated by two different sources (in particular speech communication traffic and communication control signals) are combined on the same physical channel. This system is described in 'Proposed EIA/TIA Wideband Spread Spectrum Standard', Qualcomm Inc., 15 May 1992, pages 6-32 to 6-42 and 7-27 to 7-83.

[0010] The known system admits four transmission rates between mobile stations and base stations, in particular 1200, 2400, 4800 and 9600 bits/s. The system can operate at anyone of the four rates when only speech signals are to be transmitted. When also control signals are to be transmitted, the system always operates at the maximum rate, keeping into account, first of all, the requirements of control signals: if these do not require all the available rate, speech signals can be transmitted too. This management system is scarcely flexible and under certain conditions it can lead to a deterioration of the speech signal quality; this deterioration could be avoided with a more sophisticated allocation criterion.

[0011] The aim of the invention is to provide a method of controlling transmission, and a system using the method, where the choice of the transmission rate is effected on the basis of a joint assessment of the needs of the individual information streams so as to keep the quality of service constant.

[0012] According to the invention, a method is therefore provided of controlling transmission on a same radio channel (in particular, a radio channel of a mobile communication system) of variable-rate information streams related to the same communication and originated from different sources, in which each stream is emitted by a source at a rate which is selected, in a given time interval, within a respective set of source rates and the stream is associated, before being sent on the channel, to a redundancy which is selected within a set of possible redundancy schemes and determines an increase of the stream rate, the method being characterised in that, in the said interval, there are assessed the source needs in terms of the emission rate which is best suited to the stream characteristics, the channel needs in terms of the redundancy to be associated with the individual streams, and the system needs in terms of the channel rate, wherein, for guaranteeing the attainment of a predetermined quality of the particular communication and of the service offered by the system, each stream is allocated the emission rate and the redundancy which meet the respective needs if the total rate resulting from the combination of the streams on the channel, expressed as the sum of the stream

emission rates and the rate increments due to the redundancies, does not exceed a rate imposed by the system conditions, and otherwise each stream is allocated such an emission rate and such a redundancy as to minimize a cost of the communication, linked to the quality of the particular communication and of the service offered by the system, and given by the sum of the costs resulting from the individual needs.

[0013] The communication system utilizing the method comprises at least two stations connected via radio channels and comprising: sources of variable-rate information streams related to a same communication, which streams must be combined on the same radio channel, each source being able to operate, in a given time interval, at a rate chosen within a respective set of rates; means to introduce into each stream, in the said time interval, a redundancy chosen within a set of possible redundancy schemes, each of which causes an increase in the rate of the stream emitted by the source; means to combine the individual streams into a single stream to be transmitted on the channel; and management units of the stations; and is characterized in that said stations are associated with a control unit of the variable-rate streams, which unit, for each communication, receives from the sources information related to the respective needs in terms of the emission rate which is best suited to the characteristics of the respective information stream in that interval, and receives from the management units information about the needs of the channel and of the whole system during that interval, expressed in terms of redundancy to be introduced and respectively of transmission rate on the channel, determines a particular source rate and a particular redundancy for each stream which rate and redundancy guarantee the attainment of a predetermined quality of the particular communication and of the service offered by the system, and supplies the sources and the means for introducing redundancy with commands for the choice of a particular source rate and of that particular redundancy, the rates and the redundancies chosen being those which satisfy the source and channel needs in that interval, if the total rate of the stream resulting from the combination, expressed as the sum of the emission rates of the streams and the rate increments caused by the redundancies, does not exceed a rate determined by the system conditions, while otherwise the rates and redundancies are chosen so as to minimize a total cost of the communication, linked to the quality of the particular communication and of the service offered by the system, and given by the sum of the costs resulting from the individual needs.

[0014] Preferably, the two stations are a mobile station and a fixed part (base station and radio network control) of a mobile communication system.

[0015] The invention will be better understood with reference to the annexed drawings, where:

- Fig. 1 is a general scheme of a mobile communication system utilizing the invention;
- Fig. 2 is a block diagram of the control unit according to the invention; and
- Fig. 3 is a flow chart of the operations of the unit of Fig. 2.

[0016] In Fig. 1 the mobile communication system in which the invention is applied is schematized by a set of mobile stations M1 ... Mh, by a set of base stations B1 ... Bn, connected to the mobile stations by means of radio channels to which the stations have access according to code division techniques, and by a radio-network control centre RNC.

[0017] As indicated for M1, for variable-rate speech and control signal transmission a mobile station ideally comprises:

- a speech coder CV1 which receives speech signals from microphone MF and emits on a connection 1 a coded signal at a rate r_1 generally variable frame by frame; for example CV1 can be based on analysis-by-synthesis techniques; for the purpose of the invention, CV1 constitutes the source of the respective information stream;
- a source CS1 of control signals issuing on a connection 2 a stream at a rate r_2 which is also generally variable frame by frame; in general the whole stream of control signals (hereinafter referred to also as "signalling") to be transmitted by the mobile stations to the base station will be generated locally and block CS1 schematizes the whole of the units producing this signalling;
- channel coders CC1, CC2 for speech signals and control signals, respectively, which coders receive the signals generated by CV1, CS1 and associate them with a redundancy, which in general is also variable frame by frame and results in a rate increase r_3 , r_4 ; coders CC1, CC2 can be of any of the types used in mobile communication systems; e.g. channel coding can be based on convolutional coding.

[0018] Information streams present on outputs 3, 4 of the channel coders are combined by a multiplexer MX1 into a single stream sent through connection 5 to the CDMA transmitter T1, which forwards it on radio channel 6. MX1 and T1 incorporate all the units needed to organize the transmission according to the protocols required by the particular communication system.

[0019] Rates and redundancies r_1 , r_2 , r_3 , r_4 to be adopted at a given time interval (e.g. a frame in a code division transmission) are communicated to blocks CV1, CS1, CC1, CC2 through connections 7-10 by a unit UC1 controlling the variable-rate transmission. UC1, which constitutes the subject matter of the invention, communicates to MX1 also the information about total rate $r_{tot} = r_1 + r_2 + r_3 + r_4$ through connection 15. The rates are determined by UC1 keeping into

account the needs of speech, signalling, channel and system.

[0020] The needs of speech and signalling can be represented by information related to the rate best suited for coding the particular speech segment or for signalling transmission in that stage. Channel conditions, which can vary both in time and depending on the position of the mobile, can be e.g. represented by information on the measured error rate, determining the protection needs of the signals and therefore the redundancy which channel coders CC1, CC2 must introduce. Finally, the system conditions, which determine the rate actually available on channel 6, depend on traffic conditions: e.g. low traffic conditions can allow a higher transmission rate for speech and therefore a better quality of the same, which can be obtained e.g. by a wide-band coding, while heavy traffic conditions can set limits to maximum data rate.

[0021] The information about the needs of CV1 and CS1 is supplied by such units to UC1 through connections I1, I2; the information related to the conditions of radio channel 6 and of the system are supplied through connections I3, I4 by a mobile station management unit MM. In general the information on the channel and on the system is not, or is not all, available to MM, which to this purpose must dialogue with the base station management unit BM, as outlined by logical connection I6.

[0022] Considering that the output quantities from UC1, i.e. the rates, are discrete quantities, it has been deemed convenient that also the input quantities should be discrete quantities, which can be represented by indices I1...I5. In particular:

- I1 ($1 \leq I1 \leq N1$) identifies which of N1 possible operating rates of the coder CV1 is best suited for speech coding in that frame; in an exemplary embodiment, seven rate values were foreseen for CV1, ranging from 400 bit/s to 16 kbit/s;
- I2 ($1 \leq I2 \leq N2$) identifies one of N2 possible transmission rates for control signals; in the said exemplary embodiment, four possible rate values were foreseen, e.g. 0, 2, 4, 8 kbit/s;
- I3, I4 ($1 \leq I3 \leq N3$ and $1 \leq I4 \leq N4$) identify one of the possible protection schemes and therefore one of the possible redundancies to be used for speech and signalling, respectively; in general, for both types of signals, the choice will be between a strong protection and a mild protection even if the same scheme uses different redundancies for the two types of signals; a single index can therefore be used to indicate the channel needs; the example considered adopted this solution with redundancies ranging from 0.6 to 11 kbits/s or from 0.6 to 15 kbits/s for speech (respectively in the case of mild or strong protection) and from 0 to 10 kbit/s or from 0 to 22 kbit/s for signalling;
- I5 ($1 \leq I5 \leq N5$) identifies one of N5 occupancy levels of the system (with level 1 corresponding to minimum occupancy) and therefore one of N5 possible rates on channel 6; in the example considered, the channel rates varied between 1 kbit/s and 40 kbit/s, in steps of 1 kbit.

[0023] On the basis of this information, UC1 determines rates $r_1...r_4$ so as to satisfy entirely the rate and protection requirements of the different streams, if this is allowed by the system conditions; otherwise the rates are determined so as to minimize the total cost which must be paid to obtain a predetermined quality. Total cost will be represented by the sum of the costs linked with the individual needs. These costs in the described embodiment are digital values which give, for instance, an indication of the distortion associated with a certain rate of the coded signal (for speech) or with certain conditions of the channel or the system, or of the time required for the execution of a procedure (for control signals). These values can be determined a priori, e.g. by means of a simulation, and improved by field measurements during a stage of experimental running of system. Costs connected with the different needs must be normalized with respect to a common base. To simplify the realization, costs can be considered constant, and the described example refers to this case.

[0024] A possible example of cost minimization algorithm will be described with reference to Fig. 3.

[0025] A set of units similar to the one described is present also in the fixed part of the system, for managing communication towards the mobile. CV2, CS2, CC3, CC4, MX2, T2, UC2 correspond to the units CV1, CS1, CC1, CC2, MX1, T1, UC1 of the mobile; RNCM, BM are the management units of the radio network control unit and of the base station. References 1'...15' indicate connections corresponding to the connections 1...15 of the mobile.

[0026] As it can be seen, the devices concerned with the management of the communication towards the mobile are shared between the base station and the network control unit RNC. In particular, the devices more directly involved in the transmission aspects (channel coders, multiplexer, transmitter) are located in the base station; the speech coder, the control signal source and the control unit of the variable-rate transmission are located in the network control unit. The information about the channel and system conditions are supplied to UC2 by the network control management unit RNCM which dialogues with management unit BM of the base station in order both to obtain information about the channel and/or system conditions available only in BM, and to supply BM with the information about channel and/or system conditions to be sent to MM. The logical connection between BM and RNCM is indicated by 17. Moreover in this case the control signals are partly generated locally and partly will arrive from the land network (not represented),

from which the speech to be coded arrives to CV2. Connections with the land telecommunications network are indicated by 18, 19 for speech and control signals, respectively.

[0027] It should however be noted that the system organization shown in the Figure is a logical organization which is used to explain the location of the invention in the system and the operations performed by the invention, and it has no binding character on the real location of the units performing the functions described. In particular, logical connection 16 between BM and MM will be physically realized by means of an exchange of signalling through channel 6.

[0028] The receiving part, both in the mobile station and in the fixed part is not concerned by the invention and therefore it is not represented.

[0029] Fig. 2 shows the structure of a control unit UC, e.g. UC1. The unit comprises two groups of memories associated with each of the inputs, i.e. memories ME1-1, ME1-2, ... ME1-5, and memories ME2-1, ME2-2, ... ME2-5, and a processing unit EL which executes the cost minimizing algorithm using the data read in the memories.

[0030] Memories ME1 store a parameter relevant to the stream rate at the output from the source, the channel coder and the multiplexer; the parameter is a vector (for the inputs associated with indices I1, I2, I5) or a matrix (for I3, I4). Memories ME2 store a matrix of costs. Considering that the emission rates and the redundancy schemes are fixed for a given configuration of the communication system and supposing that costs are constant, memories ME1, ME2 are read only memories.

[0031] Rate vectors $\bar{R1} = [r_1(1), r_1(2) \dots r_1(N1)]$, $\bar{R2} = [r_2(1) \dots r_2(N2)]$ and $\bar{R5} = [r_5(1) \dots r_5(N5)]$ are vectors with N1, N2 or respectively N5 components, corresponding each to one of the possible operation rates of CV1 and CS1 or one of the N5 transmission rates on channel 6. The components are ordered according to increasing values from the first to the N1-th or N2-th for $\bar{R1}$, $\bar{R2}$, and in a decreasing order from $r_5(1)$ to $r_5(N5)$ for $\bar{R5}$. The memories are addressed at each frame by I1, I2, I5 and supply EL, through connections 21, 22, 25, with the vector component read in each of them.

Cost matrices

$$\bar{\bar{C1}} = \begin{bmatrix} c_1(1,1) & c_1(1,2) & \dots & c_1(1,N1) \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ c_1(N1,1) & \dots & \dots & c_1(N1,N1) \end{bmatrix} \quad \bar{\bar{C2}} = \begin{bmatrix} c_2(1,1) & c_2(1,2) & \dots & c_2(1,N2) \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ c_2(N1,1) & \dots & \dots & c_2(N2,N2) \end{bmatrix}$$

stored in ME2-1, ME2-2 are addressed by rows by index I1 or respectively I2 and by columns by an index i, or respectively j, generated during the communication cost minimizing algorithm. Indices i, j can take values varying from I1 (I2) to 1, including the extreme values. Indices i, j are supplied by EL through connections 41, 42. The datum read is supplied to EL through connections 31, 32. In each row the costs decrease as the column index increases.

[0032] Costs c_1 can for example express a measure of the perceptual distortion associated with a particular combination requested rate - allocable rate. Costs c_2 can be the expression of the quality of service represented e.g. as the time for the execution of a procedure and therefore as the probability that the procedure itself could be completed in a preset time. In practice, since i, j can never exceed I1, I2, the matrices are triangular matrices, where only the values below the diagonal differ from 0; the costs on the diagonal can be allotted the value 0, where 'cost 0' means that the system is able to supply exactly the requested rate. The same convention will be adopted for the other cost matrices.

Cost matrix

$$\bar{\bar{C5}} = \begin{bmatrix} c_5(1,1) & \dots & c_5(1,N5) \\ \dots & \dots & \dots \\ c_5(N5,1) & \dots & c_5(N5,N5) \end{bmatrix}$$

stored in ME2-5 is addressed by index I5 for the rows and by an index Ir, associated with the total rate r_{tot} and generated during the cost minimization algorithm, for the columns. Index Ir is present on a connection 45.

[0033] It is to be noted that, when r_{tot} lies between two consecutive values of r_5 , index Ir is associated with the higher value: i.e., considering that the rates in $\bar{R5}$ are decreasing, $\bar{R5}(Ir+1) < r_{tot} \leq \bar{R5}(Ir)$. Costs c_5 decrease along the rows.

[0034] In matrix $\overline{C5}$ costs $c_5(p,q)$ with $p > q$ correspond to system rates greater than total rate and therefore can be considered as negative costs; the opposite for $p < q$. The datum read in $\overline{C5}$ is supplied to EL through connection 35.

[0035] The third and fourth inputs are associated with memories ME1-3, ME1-4 and ME2-3, ME2-4 storing respective rate matrices $\overline{R3}$, $\overline{R4}$ and cost matrices $\overline{C3}$, $\overline{C4}$. The two rate matrices

$$\overline{R3} = \begin{bmatrix} r_3(1,1) & \dots & r_3(1,N3) \\ \dots & \dots & \dots \\ r_3(N1,1) & \dots & r_3(N1,N3) \end{bmatrix} \quad \overline{R4} = \begin{bmatrix} r_4(1,1) & \dots & r_4(1,N4) \\ \dots & \dots & \dots \\ r_4(N2,1) & \dots & r_4(N2,N4) \end{bmatrix}$$

contain N1 or respectively N2 rows corresponding to the N1 or N2 source rates, and N3 or respectively N4 columns (with $N3 = N4$ in the example considered) whose number is equal to the number of foreseen channel coding schemes. Rate values in the rows of the two matrices increase as the column index increases. Reading pointers in the two matrices are respectively I1, I2 for the rows and I3 for the columns. The data read are presented on connections 23, 24. The two matrices are constant.

Cost matrices

$$\overline{C3} = \begin{bmatrix} c_3(1,1) & \dots & c_3(1,N3) \\ \dots & \dots & \dots \\ c_3(N3,1) & \dots & c_3(N3,N3) \end{bmatrix} \quad \overline{C4} = \begin{bmatrix} c_4(1,1) & \dots & c_4(1,N4) \\ \dots & \dots & \dots \\ c_4(N4,1) & \dots & c_4(N4,N4) \end{bmatrix}$$

stored in ME2-3, ME2-4 are totally similar to matrices $\overline{C1}$, $\overline{C2}$. Costs can represent a distortion introduced by the channel on the respective signal: for the speech this will be a perceptual distortion, as is the case of $\overline{C1}$, while for control signals it will be a probability that the signal could not be interpreted correctly.

[0036] The two matrices are addressed by rows by I3, while columns will be addressed by an index k, supplied by EL through connection 43, which is generated during the cost minimization algorithm and which can vary from I3 to 1. The data read are supplied to EL through connections 33, 34.

[0037] Figure 3 contains the flow chart of the algorithm. At each frame, the rate vector/matrix components addressed by indices I1 ... I5 and the values of the indices are loaded in EL (step 101). Said components are indicated as $r_{m(\min)}$ where $m = 1, 2, 3, 4$. The corresponding total rate

$$r_{\text{tot}(\min)} = \sum_{m=1}^4 r_{m(\min)}$$

is then determined and compared with rate r_5 permitted by the system (steps 102, 103). If $r_{\text{tot}(\min)}$ does not exceed r_5 , the four rates requested are accepted and the relevant commands are emitted for blocks CV1, CS1, CC1, CC2, MX1 (CV2 ... MX2) (step 104).

[0038] If the total rate required exceeds system rate r_5 , it is necessary to pass on to cost evaluation. Total cost of the request is initialized to a value $C_{\min} = \infty$ (step 105) and every possible rate combination, equal to or lower than those indicated by indices I1 - I4, is tested (steps 106-109). The combinations different from the initial one are obtained by diminishing the individual indices by 1 unit, independently from one another. Indices i, j, k represent the values assigned to I1, I2, I3 at a given step of the test. For each combination of i, j, k, the total rate is calculated again (step 110) and is compared now with the maximum rate admissible on the channel (step 111). If the total rate is higher than maximum rate, the only possibility is to try a combination of lower values, otherwise the cost of the combination under test will be assessed. Comparison with maximum rate and not with system rate r_5 means that the possibility is also envisaged of allocating the communication a total rate which is higher than the system rate, by paying the respective price, represented by cost $c_5(I5, I_r)$.

[0039] For cost assessment, it is necessary to determine index I_r (step 112) and to calculate total cost C_{tot} , as the

sum of the costs addressed in the individual matrices $\overline{C1} \dots \overline{C5}$ (step 113). This cost is compared with value C_{\min} (∞ if the initial combination is being assessed) (step 114) and whenever a total cost is lower than the one stored in memory this value is updated. Also the corresponding values $r_1 \dots r_4, r_{\text{tot}}$ are stored. At the end of the test on all the combinations of indices i, j, k , unit EL will supply values $r_1 \dots r_4, r_{\text{tot}}$ determined.

[0040] It is clear that trying all possible combinations of values of i, j, k can be effected so long as indices I1 ... I5 have a limited number of values, as in the example given. Under these conditions, control unit UC2 could also simultaneously manage several communications. If the number of combinations is too high, dynamic programming techniques, tree selection techniques and so on, can be used, which allow discarding beforehand a number of combinations.

[0041] It is clear that what described has been given only by way of non limiting example, and that variations and modifications are possible without going out of the scope of the invention.

[0042] For example, even if the matrices $\overline{C1} \dots \overline{C5}$ have been assumed to be constant for all frames, it is possible to update the values periodically. As an alternative to storage as matrices, the costs related to source and channel conditions could be organized into vectors, corresponding to the first column of the respective matrices; these vectors would vary on a frame by frame basis. Moreover, the cost vector relative to the second input would also be a function of the choice made in the preceding frames, since each choice influences the probability that the procedure can be brought to successful conclusion within the time set.

[0043] Furthermore, the invention can be applied for services other than speech transmission, such as variable-rate data transmission in which the two streams would be represented by the data and by the signalling, or in systems employing access techniques different from CDMA but always in connection with variable-rate transmissions, e.g. PRMA (Packet Reservation Multiple Access) or ATM (Asynchronous Transfer Mode) techniques. Moreover, even if the invention has been disclosed in connection with a mobile communication system, it can be also applied to other radio communication systems comprising at least two stations connected via radio channels, in particular satellite communication systems.

Claims

1. Method of controlling transmission, on a same radio channel, of variable-rate information streams relative to the same communication and originated from different sources, in which each stream is emitted by a source (CV1, CS1; CV2, CS2) at a rate (r_1, r_2) which, in a given time interval, is chosen within a respective set of source rates and the stream is associated, before being sent on the channel (6), with a redundancy which is chosen within a set of possible redundancy schemes and which determines an increment (r_3, r_4) in the stream rate, **characterized in that** during the said interval there are assessed the source needs in terms of the emission rate suited to the stream characteristics, the channel needs in terms of the redundancy to be associated with the individual streams, and the system needs in terms of channel rate, wherein, for guaranteeing a predetermined quality of the particular communication and of the service offered by the system, each stream is allocated the emission rate and the redundancy which meet the respective needs if the total rate (r_{tot}) resulting from the combination of the streams on the channel, expressed as the sum of the stream emission rates and the rate increments due to the redundancies, does not exceed a rate (r_5) imposed by the system conditions, and otherwise each stream is allocated such an emission rate and such a redundancy as to minimize a cost of the communication, linked to the quality of the particular communication and of the service offered by the system, and given by the sum of the costs resulting from the individual needs.
2. Method according to Claim 1, **characterized in that** the radio channel is the communication channel between a mobile station and a base station of a mobile communication system, and the assessment of said needs is performed separately in the mobile station and in a fixed part of the system, respectively for the direction from the mobile station towards the fixed part and for the opposite direction.
3. Method according to Claim 1 or 2, **characterized in that**, for each direction of the communication, the information on said needs are represented by indices (I1 ... I5), linked to one of the possible source rates of each stream, to one of the possible redundancy schemes and to one of the possible channel rates.
4. Method according to Claim 3, **characterized in that** said indices constitute reading addresses for accessing stored information on the emission and channel transmission rates and on the rate increments caused by the redundancies, as well as on the costs associated with the rates and redundancies actually allocable.
5. Method according to Claim 4, **characterized in that** the information on the channel needs is represented by a single index for all information streams.

6. Method according to any of Claims 3 to 5, **characterized in that** the stored information relative to the source rates and to the channel rates consists of vectors with as many components as there are possible rate values, and the information on the rate increments caused by the redundancies is represented by matrices in which each component is associated with a combination of source/redundancy rates.

7. Method according to any of Claims 3 to 6, **characterized in that** the stored information relative to costs is in the form of digital values, normalized with respect to a common base and organized into matrices in which each component is associated with a combination of rates/redundancies required and rates/redundancies allocable.

8. Method according to Claim 7, **characterized in that** said cost matrices are constant matrices.

9. Method according to any of Claims 3 to 6, **characterized in that** the information stored relative to costs related to the source and channel needs is in the form of digital values organized into vectors, updated at every time interval.

10. Method according to any preceding claim, **characterized in that** the information streams are digitally coded speech signals and control signals of a speech communication.

11. Method according to any of Claims 1 to 9, **characterized in that** the information streams are data and control signals of a variable-rate data transmission.

12. Method according to claim 2 or any of claims 3 to 11 if referred to claim 2, **characterized in that** the mobile communication system is a system in which channel access occurs according to code division techniques and the transmission period on the channel is divided into frames, and **in that** the determination of the rate and of the redundancy to be allocated to the individual streams is made at each frame.

13. Method according to claim 2 or any of claims 3 to 11 if referred to claim 2, **characterized in that** the communication system is a system in which channel access for variable-rate transmissions occurs according to time division technique.

14. Communication system including at least two stations (M1 ... Mh; RNC; B1 ... Bn) connected via radio channels and including:

- sources (CV1, CS1; CV2, CS2) of variable-rate information streams relative to a single communication which streams must be combined on a single radio channel (6), each source being able to operate, in a given time interval, with a rate (r_1, r_2) chosen within a respective set of rates;
- means (CC1, CC2; CC3, CC4) to introduce into each stream, in said time interval, a redundancy chosen from a set of possible redundancy schemes, each of which causes an increment (r_3, r_4) in the rate of the stream emitted by the source;
- means (MX1, MX2) to combine the individual streams into a single stream to be transmitted on the channel (6);
- management units (MM, BM, RNCM) of the stations;

characterized in that said stations are associated with a variable-rate stream control unit (UC1, UC2) which, for each communication: receives from the sources (CV1, CS1; CV2, CS2) information on the source needs in terms of the emission rate suited to the characteristics of the respective information stream **in that** interval; receives from the management units (MM, RNCM) information on the needs of the channel (6) and of the entire system **in that** interval, expressed in terms of redundancy and respectively of transmission rate on the channel; determines a particular source rate and a particular redundancy for each stream which rate and redundancy guarantee the attainment of a predetermined quality of the particular communication and of the service offered by the system, and provides the sources (CV1, CS1; CV2, CS2) and the means (CC1, CC2; CC3, CC4) for redundancy introduction with commands for the choice of that particular source rate and of that redundancy, the rates and redundancies chosen being those which satisfy the source and channel needs **in that** interval, if the total rate (r_{tot}) of the stream resulting from the combination, expressed as the sum of the emission rates of the streams and the rate increments caused by the redundancies, does not exceed a rate (r_5) determined by the system conditions, while otherwise the rates and redundancies are chosen so as to minimize a total cost of the communication, linked to the quality of the particular communication and of the service offered by the system, and given by the sum of the costs resulting from the individual needs.

15. Communication system according to Claim 14, **characterized in that** each control unit (UC1; UC2) includes:

- a first group of memories (ME1-1 ... ME1-5), which store information relative to the possible rates of the streams emitted by the sources, to the combinations of each of these rates with each of the redundancies foreseen for the respective stream, and to the possible rates on the channel, and which are addressed respectively by the information on the needs of the sources (CV1, CS1; CV2, CS2), of the channel (6) and of the system supplied by the sources (CV1, CS1; CV1, CS2) and the management units (MM, RNCM), respectively;
 - a second group of memories (ME2-1 ... ME2-5), which store information on the costs associated with the possible choices of rates of the streams flowing from the sources, of the redundancy required by the channel conditions and of the rate on the channel (6), and are addressed in reading at least by the information provided by the sources (CV1, CS1; CV2, CS2) and by the management units (MM, RNCM);
 - a processing unit (EL), which receives from the sources (CV1, CS1; CV2, CS2) and from the management units (MM, RNCM) information on the source, channel and system needs, and from the first and second group of memories (ME1-1 ... ME1-5, ME2-1 ... ME2-5) information on the rates, redundancies and costs, and provides the sources (CV1, CS1; CV2, CS2) and the means (CC1 ... CC4) of redundancy introduction with commands for the choice of the emission rate and of the redundancy.
16. Communication system according to Claim 14 or 15, **characterized in that** the sources (CV1, CS1; CV2, CS2) and the management units (MM, RNCM) provide the information on the source, channel and system needs in the form of indices (I1 ... I5) which constitute reading addresses or parts of the reading addresses in said memories (ME1-1 ... ME2-5).
17. Communication system according to Claim 15 or 16, **characterized in that**, in the first group of memories (ME1-1 ... ME1-5), the memories (ME1-1, ME1-2, ME1-5) for the information on the source and channel needs store rate values organized into vectors, each having as many components as there are possible values for the source and channel rates, and the memories (ME1-3, ME1-4) for information on the channel needs store rate values organized into matrices in which each row is associated with one of the rate values of the respective source, and each column with one of the possible increments caused by the redundancy.
18. Communication system according to any of Claims 15 to 17, **characterized in that** the memories of the second group (ME2-1 ... ME2-5) store numerical cost values organized into matrices, and each memory location is addressed jointly by one of the said indices (I1 ... I5) and by a further index, generated by said processing unit (EL) during the determination of the rates and of the redundancies and associated with a rate or a redundancy that can be actually allocated to the individual streams emitted by the source or respectively to the total rate of the stream resulting from the combination.
19. Communication system according to Claim 18, **characterized in that** said cost matrices are constant matrices.
20. Communication system according to any of Claims 15 to 17, **characterized in that** the memories of the second group (ME2-1 ... ME2-4) storing costs related to the source and channel needs store numerical values organized into vectors, updated at each time interval.
21. Communication system according to any of Claims 14 to 20, **characterized in that** the information streams are speech signals coded in digital form and control signals of a speech communication.
22. Communication system according to any of Claims 14 to 20, **characterized in that** the information streams are data and control signals of a variable-rate data transmission.
23. Communication system according to any of Claims 14 to 22, **characterized in that** the communication system is a mobile communication system comprising a plurality of mobile stations (M1 ... Mh) and a fixed part (RNC; B1 ... Bn), consisting of base stations (B1 ... Bn) and of radio network control units (RNC), and the unit (UC1, UC2) controlling the variable rate streams is provided in each mobile station (M1 ... Mh) and in the fixed part (RNC; B1 ... Bn).
24. Communication system according to Claim 23, **characterized in that** the mobile communication system is a system in which channel access occurs through code division techniques.
25. Communication system according to Claim 23, **characterized in that** the mobile communication system is a system in which channel access for a variable-rate transmission occurs through time division techniques.

Patentansprüche

1. Verfahren zum Steuern des Sendebetriebs, auf einem selben Funkkanal, von Informationsströmen variabler Rate, die sich auf die selbe Kommunikation beziehen und von verschiedenen Quellen ausgehen, wobei jeder Informationsstrom von einer Quelle (CV1, CS1; CV2, CS2) mit einer Rate (r_1, r_2) emittiert wird, die in einem gegebenen Zeitintervall innerhalb einer jeweiligen Gruppe von Quellen-Raten gewählt wird, und dem Informationsstrom, bevor er auf dem Kanal (6) gesendet wird, eine Redundanz zugeordnet wird, die innerhalb einer Gruppe möglicher Redundanzschemen gewählt wird und eine Erhöhung (r_3, r_4) der Informationsstromrate bestimmt, **dadurch gekennzeichnet, daß** während dieses Intervalls die Quellenbedürfnisse hinsichtlich der Emissionsrate, die sich für die Informationsstromcharakteristiken eignet, die Kanalbedürfnisse hinsichtlich der Redundanz, die den einzelnen Informationsströmen zuzuordnen ist, und die Systembedürfnisse hinsichtlich der Kanalrate geschätzt werden, wobei zum Sicherstellen einer gegebenen Qualität der betreffenden Kommunikation und des vom System angebotenen Dienstes jedem Informationsstrom die Emissionsrate und die Redundanz zugeordnet werden, die die jeweiligen Bedürfnisse zufriedenstellen, wenn die gesamte Rate (r_{tot}), die aus der Kombination der Informationsströme auf dem Kanal resultiert, ausgedrückt als die Summe der Informationsstromemissionsraten und der Ratenerhöhungen aufgrund der Redundanzen, eine Rate (r_5) nicht übersteigt, die durch die Systembedingungen aufgegeben ist, und daß andernfalls jedem Informationsstrom eine solche Emissionsrate und eine solche Redundanz zugeordnet sind, daß ein Kostenaufwand der Kommunikation, der mit der Qualität der betreffenden Kommunikation und des vom System gebotenen Dienstes zusammenhängt und durch die Summe der aus den einzelnen Bedürfnissen resultierenden Kosten gegeben ist, minimalisiert wird.
2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** der Funkkanal der Kommunikationskanal zwischen einer mobilen Station und einer Basisstation eines mobilen Kommunikationssystems ist und die Schätzung der Bedürfnisse getrennt in der mobilen Station für die Richtung von der mobilen Station zu einem festen Teil des Systems, und im festen Teil für die entgegengesetzte Richtung durchgeführt wird.
3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** für jede Richtung der Kommunikation die Informationen über diese Bedürfnisse durch Indizes (I1 ... I5) wiedergegeben werden, die mit einer der möglichen Quellen-raten jedes Informationsstroms, mit einer der möglichen Redundanzschemen und mit einer der möglichen Kanalraten zusammenhängen.
4. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, daß** die Indizes Leseadressen zum Zugreifen auf gespeicherte Informationen über die Emissions- und Kanalübertragungsraten, über die Ratenerhöhungen, die durch die Redundanzen bewirkt werden, sowie über die mit den Raten und den Redundanzen, die tatsächlich zuteilbar sind, verbundenen Kosten bilden.
5. Verfahren nach Anspruch 4, **dadurch gekennzeichnet, daß** die Information über die Kanalbedürfnisse durch einen einzigen Index für alle Informationsströme wiedergegeben wird.
6. Verfahren nach einem der Ansprüche 3 bis 5, **dadurch gekennzeichnet, daß** die gespeicherten Informationen, die sich auf die Quellenraten und auf die Kanalraten beziehen, aus Vektoren mit so vielen Komponenten, als es mögliche Ratenwerte gibt, bestehen und die Informationen über die von den Redundanzen bewirkten Ratenerhöhungen durch Matrizen wiedergegeben werden, in denen jeder Komponente eine Kombination von Quellen/Redundanz-Raten zugeordnet ist.
7. Verfahren nach einem der Ansprüche 3 bis 6, **dadurch gekennzeichnet, daß** die sich auf die Kosten beziehenden gespeicherten Informationen in der Form digitaler Werte vorliegen, die in Bezug zu einer gemeinsamen Basis normalisiert und in Matrizen organisiert sind, in denen jeder Komponente eine Kombination von geforderten Raten/Redundanzen und von zuteilbaren Raten/Redundanzen zugeordnet ist.
8. Verfahren nach Anspruch 7, **dadurch gekennzeichnet, daß** die Kostenmatrizen konstante Matrizen sind.
9. Verfahren nach einem der Ansprüche 3 bis 6, **dadurch gekennzeichnet, daß** die sich auf die Kosten bezüglich der Quellen- und Kanalbedürfnisse beziehenden gespeicherten Informationen in der Form digitaler Werte vorliegen, die in Vektoren organisiert sind, welche in jedem Zeitintervall fortgeschrieben werden.
10. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** die Informationsströme digital codierte Sprachsignale und Steuersignale einer Sprachkommunikation sind.

11. Verfahren nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet, daß** die Informationsströme Daten- und Steuersignale einer Datenübertragung mit variabler Rate sind.

12. Verfahren nach Anspruch 2 oder einem der auf Anspruch 2 rückbezogenen Ansprüche 3 bis 11, **dadurch gekennzeichnet, daß** das mobile Kommunikationssystem ein System ist, in dem der Kanalzugriff gemäß einer Codeteilungstechnik erfolgt und die Sendeperiode auf dem Kanal in Rahmen geteilt ist, und daß die Bestimmung der Rate und der Redundanz, die den einzelnen Informationsströmen zugeteilt werden sollen, in jedem Rahmen durchgeführt wird.

13. Verfahren nach Anspruch 2 oder einem der auf Anspruch 2 rückbezogenen Ansprüche 3 bis 11, **dadurch gekennzeichnet, daß** das Kommunikationssystem ein System ist, bei dem der Kanalzugriff für Übertragungen variabler Rate gemäß der Zeitteilungstechnik erfolgt.

14. Kommunikationssystem mit wenigstens zwei Stationen ($M_1 \dots M_h$; RNC; $B_1 \dots B_n$), die über Funkkanäle verbunden sind, und weiterhin mit:

- Quellen (CV1, CS1; CV2, CS2) von Informationsströmen variabler Rate, die sich auf eine einzige Kommunikation beziehen, wobei diese Informationsströme auf einem einzigen Funkkanal (6) kombiniert werden müssen und jede Quelle in einem gegebenen Zeitintervall mit einer Rate (r_1, r_2) arbeiten kann, die innerhalb einer jeweiligen Gruppe von Raten gewählt ist;
- einer Einrichtung (CC1, CC2; CC3, CC4) zum Einführen einer aus einer Gruppe von möglichen Redundanzschemen ausgewählten Redundanz in jeden Informationsstrom in diesem Zeitintervall, wobei jedes der Redundanzschemen eine Erhöhung (r_3, r_4) der Rate des von der Quelle emittierten Informationsstroms bewirkt;
- einer Einrichtung (MX1, MX2) zum Kombinieren der einzelnen Informationsströme zu einem einzigen auf den Kanal (6) zu übertragenden Informationsstrom;
- Verwaltungseinheiten (MM, BM, RNCM) der Stationen;

dadurch gekennzeichnet, daß den Stationen eine Steuereinheit (UC1, UC2) des Informationsstroms variabler Rate zugeordnet ist, die für jede Kommunikation folgende Funktionen ausführt: Sie empfängt von den Quellen (CV1, CS1; CV2, CS2) Informationen über die Bedürfnisse der Quelle hinsichtlich der Emissionsrate, die sich für die Charakteristiken des betreffenden Informationsstroms in diesem Intervall eignet; sie empfängt von den Verwaltungseinheiten (MM, RNCM) Informationen über die Bedürfnisse des Kanals (6) und des gesamten Systems in diesem Intervall im Hinblick auf die Redundanz bzw. die Übertragungsrate auf dem Kanal; sie bestimmt eine spezielle Quellenrate und eine spezielle Redundanz für jeden Informationsstrom, wobei diese Quellenrate und diese Redundanz das Erzielen einer gegebenen Qualität der betreffenden Kommunikation und des vom System angebotenen Dienstes sicherstellen; und sie liefert an die Quellen (CV1, CS1; CV2, CS2) und an die Einrichtungen (CC1, CC2; CC3, CC4) für die Einführung der Redundanz Befehle für die Wahl dieser speziellen Quellenrate und dieser Redundanz, wobei die gewählten Raten und Redundanzen diejenigen sind, die die Bedürfnisse der Quelle und des Kanals in diesem Intervall zufriedenstellen, sofern die gesamte Rate (r_{tot}) des aus der Kombination resultierenden Informationsstroms, ausgedrückt als die Summe der Emissionsraten der Informationsströme und der durch die Redundanzen bewirkten Ratenerhöhungen, eine durch die Systembedingungen bestimmte Rate (r_s) nicht überschreitet, während andernfalls die Raten und Redundanzen so gewählt werden, daß ein gesamter Kostenaufwand der Kombination, der mit der Qualität der betreffenden Kommunikation und des vom System gebotenen Dienstes zusammenhängt und durch die Summe der aus den einzelnen Bedürfnissen resultierenden Kosten gegeben ist, minimiert wird.

15. Kommunikationssystem nach Anspruch 14, **dadurch gekennzeichnet, daß** jede Steuereinheit (UC1; UC2) folgende Teile enthält:

- eine erste Gruppe von Speichern (ME1-1 ... ME1-5), die Informationen bezüglich folgender Gegenstände speichern: der möglichen Raten der von den Quellen emittierten Informationsströme, der Kombinationen jeder dieser Raten mit jeder der für die jeweiligen Informationsströme vorgesehenen Redundanzen, und der möglichen Raten am Kanal; und die durch die Informationen über die Bedürfnisse der Quellen (CV1, CS1; CV2, CS2), des Kanals (6) und des von den Quellen (CV1, CS1; CV2, CS2) belieferten Systems beziehungsweise der Verwaltungseinheiten (MM, RNCM) adressiert werden;
- eine zweite Gruppe von Speichern (ME2-1 ... ME2-5), die Informationen über die mit den wählbaren Möglichkeiten der Raten der von den Quellen fließenden Informationsströme, der von den Kanalbedingungen geforderten Redundanz und der Rate am Kanal (6) zusammenhängenden Kosten speichern; und die beim Lesen

wenigstens von der Information adressiert werden, die von den Quellen (CV1, CS1; CV2, CS2) und den Verwaltungseinheiten (MM, RNCM) geliefert werden;

- eine Verarbeitungseinheit (EL), die von den Quellen (CV1, CS1; CV2, CS2) und von den Verwaltungseinheiten (MM, RNCM) Informationen über die Bedürfnisse der Quelle, des Kanals und des Systems und von der ersten und der zweiten Gruppe von Speichern (ME1-1 ... ME1-5, ME2-1 ... ME2-5) Informationen über die Raten, die Redundanzen und die Kosten empfängt und die Quellen (CV1, CS1; CV2, CS2) und die Einrichtungen (CC1 ... CC4) zur Einführung der Redundanz mit Befehlen für die Wahl der Emissionsrate und der Redundanz beliefert.

16. Kommunikationssystem nach Anspruch 14 oder 15, **dadurch gekennzeichnet, daß** die Quellen (CV1, CS1; CV2, CS2) und die Verwaltungseinheiten (MM, RNCM) die Informationen über die Bedürfnisse der Quelle, des Kanals und des Systems in Form von Indizes (I1 ... I5) liefern, welche Leseadressen oder Teile von Leseadressen in den Speichern (ME1-1 ... ME2-5) darstellen.

17. Kommunikationssystem nach Anspruch 15 oder 16, **dadurch gekennzeichnet, daß** in der ersten Gruppe von Speichern (ME1-1 ... ME1-5) die Speicher (ME1-1, ME1-2, ME1-5) für die Informationen über die Bedürfnisse der Quelle und des Kanals in Vektoren organisierte Ratenwerte speichern, von denen jeder so viele Komponenten aufweist, als es mögliche Werte der Raten der Quelle und des Kanals gibt, und die Speicher (ME1-3, ME1-4) für die Informationen über die Bedürfnisse des Kanals in Matrizen organisierte Ratenwerte speichern, bei denen jede Zeile einem der Ratenwerte der betreffenden Quelle und jede Spalte einer der möglichen durch die Redundanz bewirkten Erhöhungen zugeordnet sind.

18. Kommunikationssystem nach einem der Ansprüche 15 bis 17, **dadurch gekennzeichnet, daß** die Speicher der zweiten Gruppe (ME2-1 ... ME2-5) in Matrizen organisierte numerische Kostenwerte speichern und jede Speicherstelle gemeinsam durch einen der Indizes (I1 ... I5) und durch einen weiteren Index, der von der Verarbeitungseinheit (EL) während der Bestimmung der Raten und der Redundanzen erzeugt wird und einer Rate und einer Redundanz zugeordnet ist, die tatsächlich den einzelnen von der Quelle emittierten Informationsströmen bzw. der gesamten Rate des aus der Kombination resultierenden Informationsstroms zugeteilt werden können, adressiert wird.

19. Kommunikationssystem nach Anspruch 18, **dadurch gekennzeichnet, daß** die Kostenmatrizen konstante Matrizen sind.

20. Kommunikationssystem nach einem der Ansprüche 15 bis 17, **dadurch gekennzeichnet, daß** die Speicher der zweiten Gruppe (ME2-1 ... ME2-4), die die auf die Bedürfnisse der Quelle und des Kanals bezogenen Kosten speichern, in Vektoren organisierte numerische Werte speichern, die in jedem Zeitintervall fortgeschrieben werden.

21. Kommunikationssystem nach einem der Ansprüche 14 bis 20, **dadurch gekennzeichnet, daß** die Informationsströme Sprachsignale, die in digitaler Form codiert sind, und Steuersignale einer Sprachkommunikation sind.

22. Kommunikationssystem nach einem der Ansprüche 14 bis 20, **dadurch gekennzeichnet, daß** die Informationsströme Daten- und Steuersignale einer Datenübertragung mit variabler Rate sind.

23. Kommunikationssystem nach einem der Ansprüche 14 bis 22, **dadurch gekennzeichnet, daß** das Kommunikationssystem ein mobiles Kommunikationssystem ist, das eine Mehrzahl mobiler Stationen (M1 ... Mh) und einen festen Teil (RNC; B1 ... Bn), bestehend aus Basisstationen (B1 ... Bn) und Funknetz-Steuereinheiten (RNC), umfaßt, und daß die die Informationsströme variabler Rate steuernde Einheit (UC1, UC2) in jeder mobilen Station (M1 ... Mh) und im festen Teil (RNC; B1 ... Bn) vorhanden ist.

24. Kommunikationssystem nach Anspruch 23, **dadurch gekennzeichnet, daß** das mobile Kommunikationssystem ein System ist, bei dem der Kanalzugang durch Codeteilungstechniken erfolgt.

25. Kommunikationssystem nach Anspruch 23, **dadurch gekennzeichnet, daß** das mobile Kommunikationssystem ein System ist, bei dem der Kanalzugang für eine Übertragung mit variabler Rate über Zeitteilungstechniken erfolgt.

Revendications

1. Procédé de gestion de la transmission, sur un même canal radioélectrique, de flux d'informations à débit variable concernant la même communication et provenant de sources différentes, dans lequel chaque flux est émis par une source (CV1, CS1; CV2, CS2) à un débit (r_1 , r_2) qui, dans un intervalle de temps donné, est choisi dans un ensemble correspondant de débits de sources, et le flux est associé, avant d'être envoyé sur le canal (6), à une redondance qui est choisie dans un ensemble d'arrangements de redondance possibles et qui détermine un incrément (r_3 , r_4) pour le débit du flux, **caractérisé en ce que**, pendant ledit intervalle de temps, il est effectué une estimation des besoins des sources en ce qui concerne le débit d'émission correspondant aux caractéristiques des flux, des besoins du canal en ce qui concerne la redondance à associer aux flux individuels, et des besoins du système en ce qui concerne le débit du canal, où, pour garantir une qualité prédéterminée de la communication particulière et du service offert par le système, à chaque flux est alloué le débit d'émission et la redondance qui satisfont aux besoins respectifs, si le débit total (r_{tot}) résultant de la combinaison des flux sur le canal, exprimé par la somme des débits d'émission des flux et des incréments de débit dus aux redondances, n'excède pas un débit (r_5) imposé par les conditions du système, et, autrement, il est alloué à chaque flux un débit d'émission et une redondance propres à minimiser le coût de la communication, lié à la qualité de la communication particulière et du service offert par le système, et donné par la somme des coûts résultants des besoins individuels.
2. Procédé selon la revendication 1, **caractérisé en ce que** le canal radioélectrique est le canal de communication entre une station mobile et une station de base d'un système de communication mobile, et l'estimation desdits besoins est effectuée séparément dans la station mobile et dans une partie fixe du système, respectivement pour le sens de la station mobile vers la partie fixe et pour le sens opposé.
3. Procédé selon la revendication 1 ou 2, **caractérisé en ce que**, pour chaque sens de communication, les informations concernant lesdits besoins sont représentées par des index (I1 ... I5), reliés respectivement à l'un des débits de sources possibles pour chaque flux, à l'un des arrangements de redondance possibles et à l'un des débits de canal possibles.
4. Procédé selon la revendication 3, **caractérisé en ce que** lesdits index constituent des adresses de lecture pour l'accès des informations stockées concernant les débits d'émission et de transmission sur le canal, concernant les incréments de débits provoqués par les redondances, et concernant les coûts associés aux débits et redondances effectivement allouables.
5. Procédé selon la revendication 4, **caractérisé en ce que** les informations concernant les besoins en canal sont représentées par un seul index pour tous les flux d'informations.
6. Procédé selon l'une quelconque des revendications 3 à 5, **caractérisé en ce que** les informations stockées, concernant les débits de sources et les débits du canal, sont constituées de vecteurs ayant autant de composantes qu'il y a de valeurs de débits possibles, et les informations concernant les incréments de débits provoqués par les redondances sont représentées par des matrices dans lesquelles chaque composante est associée à une combinaison débits de sources/redondances.
7. Procédé selon l'une quelconque des revendications 3 à 6, **caractérisé en ce que** les informations stockées, concernant les coûts, se présentent sous la forme de valeurs numériques, normalisées par rapport à une base commune et organisées en matrices dans lesquelles chaque composante est associée à une combinaison débits/redondances requis et débits/redondances allouables.
8. Procédé selon la revendication 7, **caractérisé en ce que** lesdites matrices de coûts sont des matrices constantes.
9. Procédé selon l'une quelconque des revendications 3 à 6, **caractérisé en ce que** les informations stockées, concernant les coûts liés aux besoins des sources et du canal, se présentent sous la forme de valeurs numériques organisées en vecteurs, mises à jour à chaque intervalle de temps.
10. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les flux d'informations sont des signaux vocaux codés sous forme numérique et des signaux de commande d'une communication vocale.
11. Procédé selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** les flux d'informations sont des signaux de données et de commande d'une transmission de données à débit variable.

12. Procédé selon la revendication 2 ou l'une quelconque des revendications 3 à 11 lorsqu'elles dépendent de la revendication 2, **caractérisé en ce que** le système de communication mobile est un système dans lequel l'accès au canal se fait selon des techniques de réparation de code et la période de transmission sur le canal est divisée en trames, et **en ce que** la détermination du débit et de la redondance à allouer aux flux individuels est effectuée à chaque trame.

13. Procédé selon la revendication 2 ou l'une quelconque des revendications 3 à 11 lorsqu'elles dépendent de la revendication 2, **caractérisé en ce que** le système de communication est un système dans lequel l'accès au canal pour des transmissions à débit variable se fait selon une technique de réparation dans le temps.

14. Système de communication comprenant au moins deux stations (M1 ... Mh; RNC; B1 ... Bn) connectées par des canaux radioélectriques, et comprenant:

- des sources (CV1, CS1; CV2, CS2) de flux d'informations à débit variable concernant une seule communication, lesquels flux devant être combinés sur un seul canal radioélectrique (6) et chaque source étant capable de fonctionner, dans un intervalle de temps donné à un débit (r_1 , r_2) choisi dans un ensemble de débits correspondant;
- des moyens (CC1, CC2; CC3, CC4) servant à introduire dans chaque flux, dans ledit intervalle de temps, une redondance choisie dans un ensemble d'arrangements de redondance possibles, qui provoquent chacun un incrément (r_3 , r_4) dans le débit du flux émis par la source;
- des moyens (MX1, MX2) servant à combiner les flux individuels en un seul flux à transmettre sur le canal (6);
- des unités de gestion (MM, BM, RNCM) des stations;

caractérisé en ce que lesdites stations sont associées à une unité de commande de flux à débit variable (UC1, UC2) qui, pour chaque communication: reçoit, en provenance des sources (CV1, CS1; CV2, CS2), des informations concernant les besoins des sources en ce qui concerne le débit d'émission correspondant aux caractéristiques du flux d'informations correspondant, dans cet intervalle de temps; reçoit, en provenance des unités de gestion (MM, RNCM), des informations concernant les besoins du canal (6) et du système complet dans cet intervalle de temps, exprimés, respectivement, par la redondance et par le débit de transmission sur le canal; détermine un débit de source particulier et une redondance particulière pour chaque flux, lesquels débit et redondance garantissent l'obtention d'une qualité prédéterminée de la communication particulière et du service offert par le système; et envoie des commandes aux sources (CV1, CS1; CV2, CS2) et aux moyens d'introduction de redondance (CC1, CC2; CC3, CC4), pour qu'ils choisissent ce débit de source particulier et cette redondance, les débits et redondances choisis étant ceux qui satisfont aux besoins des sources et du canal dans cet intervalle de temps, si le débit total (r_{tot}) du flux résultant de la combinaison, exprimé par la somme des débits d'émission des flux et des incréments de débits provoqués par les redondances, n'excède pas un débit (r_5) déterminé par les conditions du système, les débits et redondances étant autrement choisis de façon à minimiser le coût total de la communication, lié à la qualité de la communication particulière et du service offert par le système, et donné par la somme des coûts résultants des besoins individuels.

15. Système de communication selon la revendication 14, **caractérisé en ce que** chaque unité de commande (UC1; UC2) comprend:

- un premier groupe de mémoires (ME1-1 ... ME1-5), qui stockent des informations concernant les débits possibles pour les flux émis par les sources, concernant les combinaisons de chacun des ces débits avec chacune des redondances prévues pour le flux correspondant, et concernant les débits possibles sur le canal, et qui sont adressées, respectivement, par les informations concernant les besoins des sources (CV1, CS1; CV2, CS2), du canal (6) et du système, respectivement fournies par les sources (CV1, CS1; CV2, CS2) et les unités de gestion (MM, RNCM);
- un deuxième groupe de mémoires (ME2-1 ... ME2-5), qui stockent des informations concernant les coûts associés aux choix de débits possibles pour les flux provenant des sources, et de la redondance requise par les conditions du canal et du débit sur le canal (6), et sont adressées en lecture, au moins par les informations fournies par les sources (CV1, CS1; CV2, CS2) et par les unités de gestion (MM, RNCM);
- une unité de traitement (EL), qui reçoit, en provenance des sources (CV1, CS1; CV2, CS2) et en provenance des unités de gestion (MM, RNCM), des informations concernant les besoins des sources, du canal et du système, et, en provenance du premier et du deuxième groupes de mémoires (ME1-1 ... ME1-5, ME2-1 ... ME2-5), des informations concernant les débits, les redondances et les coûts, et qui envoie des commandes aux sources (CV1, CS1; CV2, CS2) et aux moyens d'introduction de redondance (CC1 ... CC4), pour qu'ils

choisissent le débit d'émission et la redondance.

- 5 16. Système de communication selon la revendication 14 ou 15, **caractérisé en ce que** les sources (CV1, CS1; CV2, CS2) et les unités de gestion (MM, RNCM) fournissent les informations concernant les besoins des sources, du canal et du système, sous la forme d'index (I1 ... I5) qui constituent des adresses de lecture ou des parties des adresses de lecture dans lesdites mémoires (ME1-1 ... ME2-5).
- 10 17. Système de communication selon la revendication 15 ou 16, **caractérisé en ce que**, dans le premier groupe de mémoires (ME1-1 ... ME1-5), les mémoires (ME1-1, ME1-2, ME1-5) destinées aux informations concernant les besoins des sources et du canal, stockent des valeurs de débits organisées en vecteurs, qui ont chacun autant de composantes qu'il y a de valeurs possibles pour les débits des sources et du canal, et les mémoires (ME1-3, ME1-4) destinées aux informations concernant les besoins du canal stockent des valeurs de débits organisées en matrices dans lesquelles chaque rangée est associée à l'une des valeurs de débits de la source correspondante, et chaque colonne est associée à l'un des incréments possibles provoqués par la redondance.
- 15 18. Système de communication selon l'une quelconque des revendications 15 à 17, **caractérisé en ce que** les mémoires du deuxième groupe (ME2-1 ... ME2-5) stockent des valeurs de coûts numériques, organisées en matrices, et chaque emplacement de mémoire est adressé conjointement par l'un desdits index (I1 ... I5) et par un index supplémentaire, généré par ladite unité de traitement (EL) pendant la détermination des débits et des redondances, et associé à un débit ou une redondance qui peuvent être effectivement alloués aux flux individuels émis par la source ou bien au débit total du flux résultant de la combinaison.
- 20 19. Système de communication selon la revendication 18, **caractérisé en ce que** lesdites matrices de coûts sont des matrices constantes.
- 25 20. Système de communication selon l'une quelconque des revendications 15 à 17, **caractérisé en ce que** les mémoires du deuxième groupe (ME2-1 ... ME2-4), stockant des coûts liés aux besoins des sources et du canal, stockent des valeurs numériques organisées en vecteurs, mises à jours à chaque intervalle de temps.
- 30 21. Système de communication selon l'une quelconque des revendications 14 à 20, **caractérisé en ce que** les flux d'informations sont des signaux vocaux codés sous forme numérique et des signaux de commande d'une communication vocale.
- 35 22. Système de communication selon l'une quelconque des revendications 14 à 20, **caractérisé en ce que** les flux d'informations sont des signaux de données et de commande d'une transmission de données à débit variable.
- 40 23. Système de communication selon l'une quelconque des revendications 14 à 22, **caractérisé en ce que** le système de communication est un système de communication mobile comprenant une pluralité de stations mobiles (M1 ... Mh) et une partie fixe (RNC; B1 ... Bn), constituée de stations de base (B1 ... Bn) et d'unités de commande d'un réseau radioélectrique (RNC), et l'unité (UC1, UC2) qui commande les flux à débit variable est prévue dans chaque station mobile (M1 ... Mh) et dans la partie fixe (RNC; B1 ... Bn).
- 45 24. Système de communication selon la revendication 23, **caractérisé en ce que** le système de communication mobile est un système dans lequel l'accès au canal se fait selon des techniques de réparation de code.
- 50 25. Système de communication selon la revendication 23, **caractérisé en ce que** le système de communication mobile est un système dans lequel l'accès au canal pour des transmissions à débit variable se fait selon une technique de réparation dans le temps.
- 55

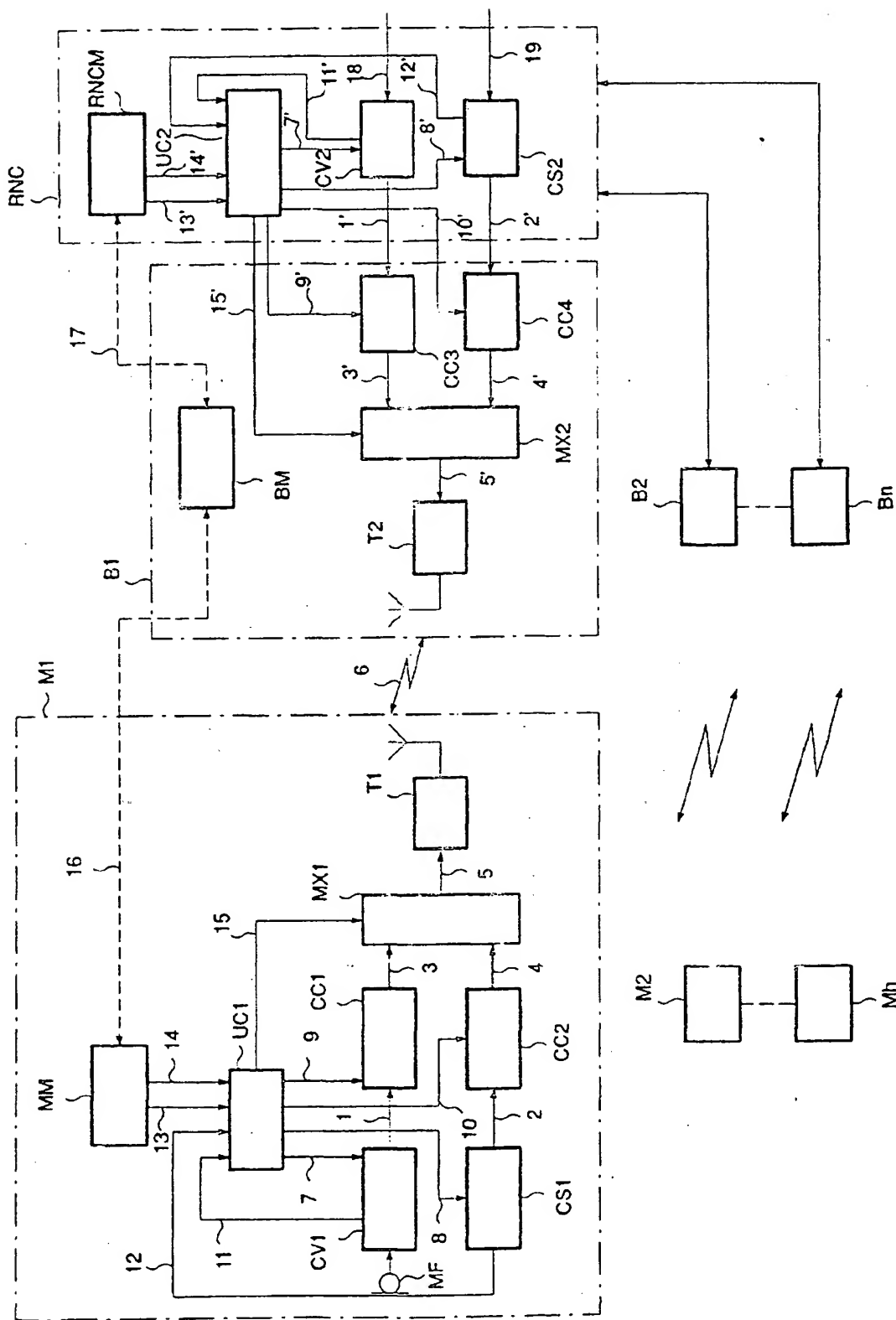


Fig. 1

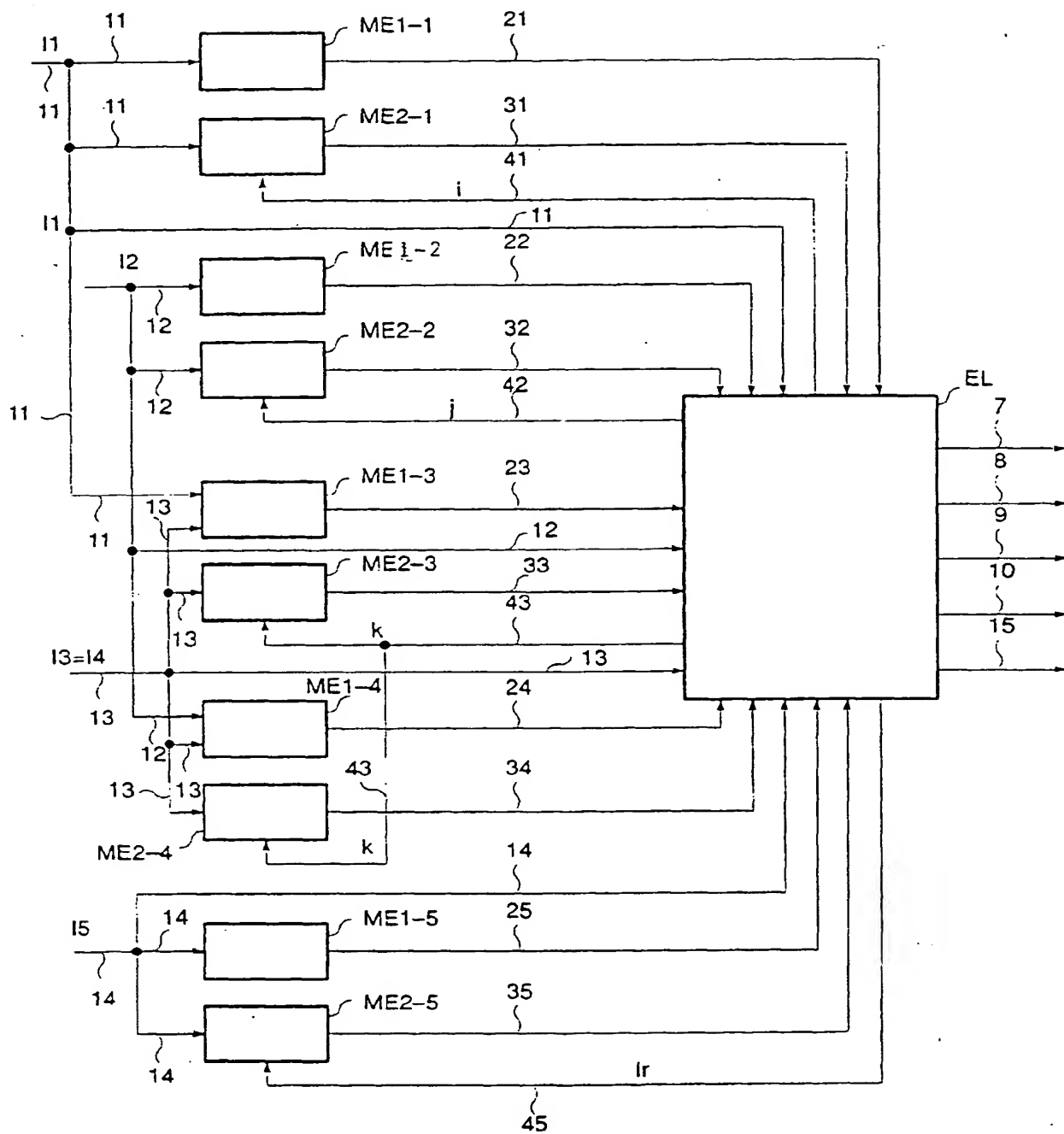


Fig. 2

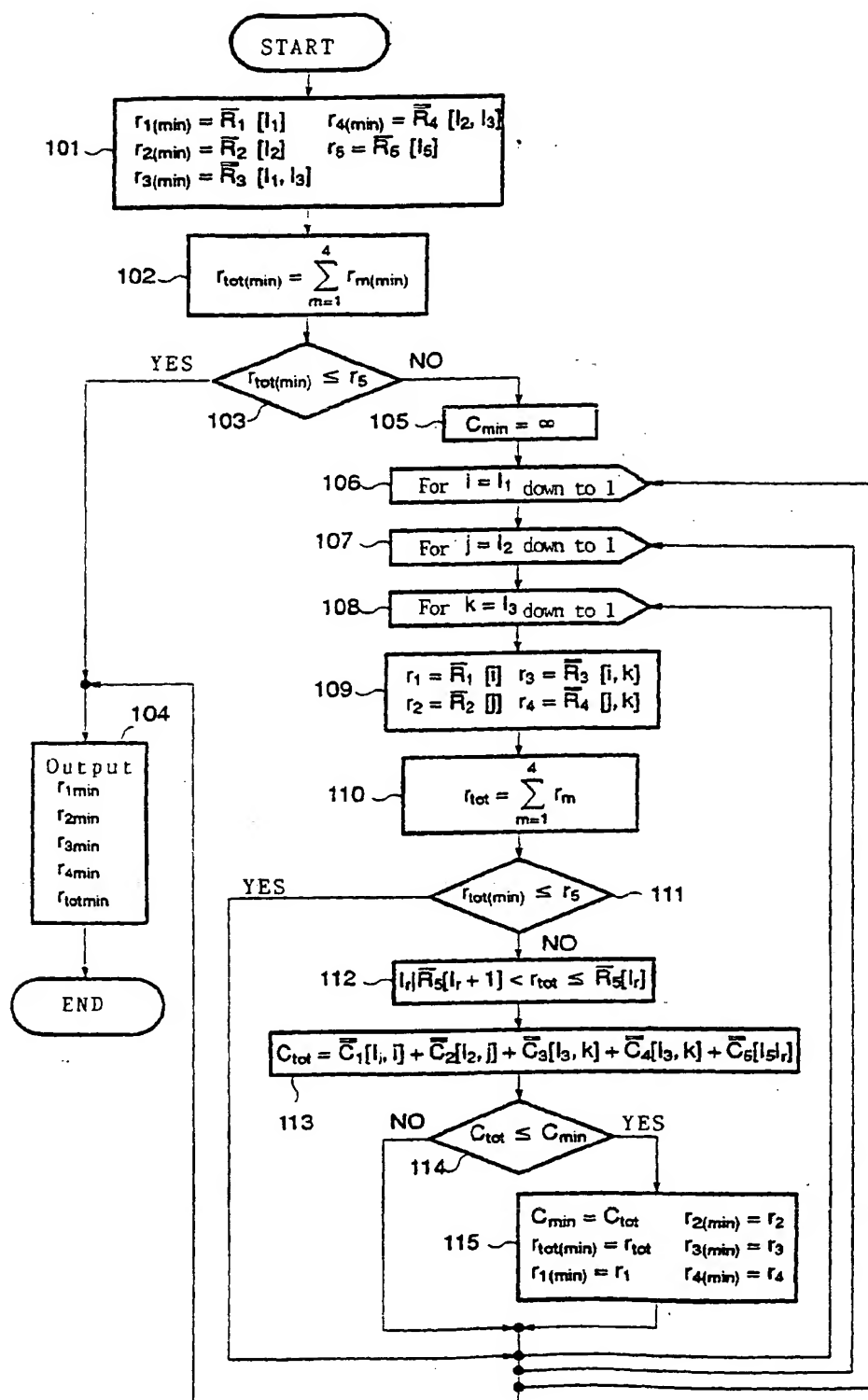


Fig. 3

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